

THE LORICATES OF THE NEOZELANIC REGION.

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INTRODUCTION.

At the special request of several New Zealand Malacologists we have undertaken the congenial task of compiling a companion to our Monograph of the Australian Loricates, dealing with the Neozelanic forms.

One or other of us has collected on Lord Howe, Norfolk, and the Kermadec Islands, and published the results of our researches, which led us to regard the marine fauna of these Islands as distinctly Neozelanic. We therefore include them in the Region, together with the Chatham, Subantarctic, and Macquarie Islands for reasons hereinafter more fully set out.

One of us also collected extensively in New Zealand, and our united collections embrace all but a few of the recently nominated forms, as well as several hitherto undescribed species. In addition to this mass of material, Miss Marjorie K. Mestayer, Drs. C. E. R. Bucknill and H. J. Finlay, Messrs. A. E. Brookes, W. R. B. Oliver, and A. W. B. Powell have generously placed their notes and material at our disposal for the purposes of further examination and illustration.

This essay must be construed as a more or less preliminary account of the Neozelanic Loricates, and its publication will, it is confidently anticipated, stimulate research and lead to the discovery of many new forms in this extremely interesting Region.

In view of the difficulty of access to some of the publications containing original descriptions, we have incorporated these throughout so that comparison can be made easily by Neozelanic students. Through this method errors of determination may be detected, as in the case hereafter noted of *Chiton circumvallatus* Reeve.

SYSTEMATICS AND STRUCTURE.

The shell-forming animals comprised in the Phylum MOLLUSCA are divided into three groups generally described as univalves, bivalves, and multivalves. The Loricates, consisting of eight overlapping valves connected by a leathery mantle or girdle, are comprised in the third group. The popular name given to the group was CHITON, from the Liunean name of the first recognised genus. Burrow (1815) wrote: "The name of the genus, CHITON, is derived from the Greek word  $\chi\iota\tau\omicron\nu\nu$  signifying a coat of mail; and aptly expresses the loricated appearance of the shell, arising from the position of the valves." Schumacher (1817) in his "Essai d'un Nouveau Système des Habitations des Vers Testacés" was the first systematist to establish the multivalves as a separate division under the ordinal name LORICATA, with the vernacular name of "Les Armurés." We suggested\* "Loricata" as a popular or vernacular name for the group, as more acceptable than Chiton, which is now the name of a very restricted genus of the group. The name LORICATA is derived from the Latin *Lorica*, which means equally a coat of mail or cuirass. Previous writers have generally adopted the

\* Australian Zoologist, iii., 1923, 186.

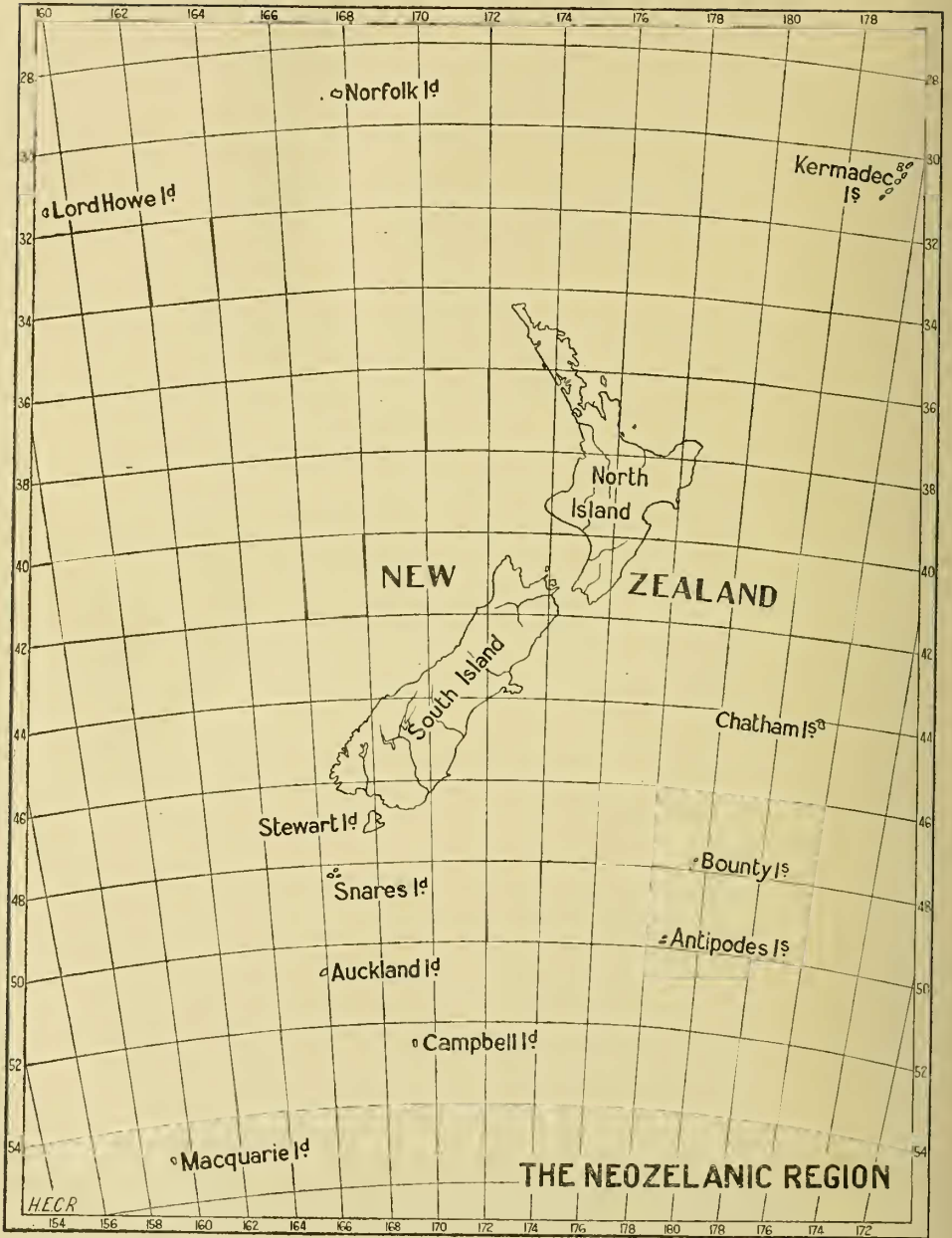


Fig. 1. MAP OF THE NEOZELANIC REGION, ON GLOBULAR PROJECTION.

ordinal name *POLYFLACOPHORA*, proposed by Gray (1821), and some have been at great pains to show that this name was adopted on the recognised grounds of priority, but, as they evidently overlooked Schumacher's name we, also on the ground of priority, adopted it, and our action has been approved by the leading scientific authorities.

These shells are popularly known, more in a dismembered state than as entire shells, by various names, amongst which may be mentioned "Coat of Mail Shells," "Butterfly Shells," "Sea Butterflies," and "Sunset Shells."

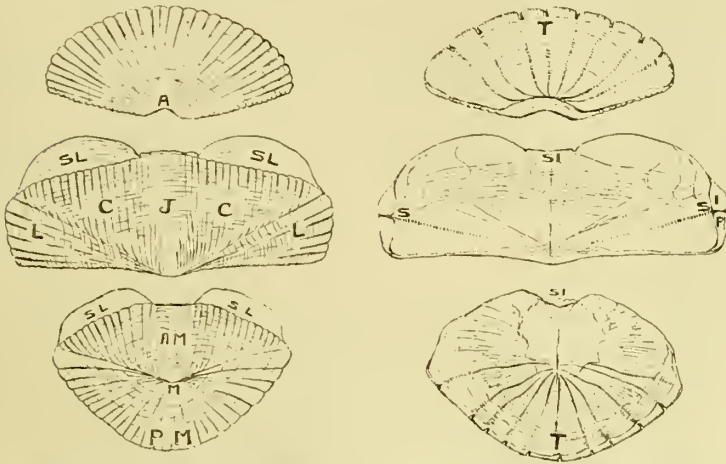


Fig. 2 (1). Exterior (tegmen) of *Rhysosoplax canaliculata* anterior, one median, and posterior valves. A.—Apex, S.L.—Sutural laminae, C.—Central areas, L.—Lateral areas, J.—Jugum, M.—Mucro, A.M.—Ante-mucronal area, P.M.—Post-mucronal area.

(2).—Interior (articulamentum) of same. T.—Teeth, I.P.—Insertion plates, S.—Slits, Si.—Sinus.

*The Shell.*—The shell of a Loricata consists of eight pieces, called *valves*, held together by a leathery *girdle*. These valves, which are composed of a chitinous foundation, reinforced by carbonate of lime, may be separated from the girdle by soaking the shell in water for a few hours, or in the case of dried specimens, by boiling in a 5 per cent. solution of caustic soda. They are of three forms; the head or *anterior* valve; six central or *median* valves, all of the same shape but differing slightly in dimensions; and the tail or *posterior* valve. They are sometimes referred to by consecutive numbers, 1 to 8, commencing with the anterior valve, which overlaps the first median valve, which in turn overlaps the second, and so on, the seventh (or sixth median) valve overlapping the anterior edge of the posterior valve. Each valve is composed of two or more layers, the outer or surface being called the *tegmen*, and the inner called the *articulamentum*. The tegmen in nearly all Loricates is divided into more or less clearly defined *areas*, which are adorned with the *sculpture*, or the *colour-pattern* which forms the basis of specific variation. The median valves are divided into two *lateral areas*, and two *central areas* connected by a *dorsal area*, or *jugum*, extending along the ridge of the valve, the posterior extremity of which, if projecting, is called the

*beak*. The line of demarcation between each lateral and central area is called the *diagonal*. As a rule the anterior valve forms a complete area as regards sculpture, which generally resembles that of the lateral areas of the median valves; occasionally the *apex* is differentiated. The posterior valve is divided into two areas by a *muero* or projection, more or less central. The area in front of the muero is styled the *antemuero*, and the area behind is styled the *postmuero* area; the former is sculptured similarly to the central areas of the median valves, and the latter is sculptured similarly to the anterior valve. In some genera the muero is so far behind the centre that the post-muero area is reduced to an inconspicuous tract, or is altogether absent.

The articulation is larger than the tegmentum, projecting in front, as regards valves 2 to 8, in two *sutural laminae*, which are separated by a bay called the *sinus*. At the sides of the median valves and round the edge of the end valves, most Loricates have projecting *insertion plates*, to which the girdle is attached. These insertion plates are generally cut into by *slits*. From the slits to the apex of each valve run more or less distinct *slit-rays*. The edges of the insertion plates between the slits are called *teeth*, which are in some genera finely cut into combs or *pectinated*; in some thickened outside or *propped*, and in some cut quite square.

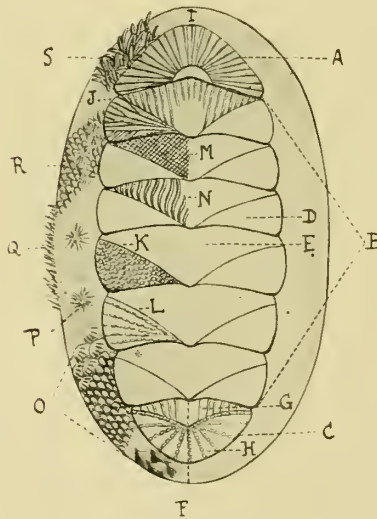


Fig. 3.—Composite diagram of a Loricata, showing the parts of the shell (A. to H.); the variations of sculpture more frequently occurring (I. to N.), and the principal varieties of girdle-covering (O. to S.).

A.—Anterior valve, B.—Median valves, C.—Posterior valve, D.—Lateral area, E. Central area, F.—Muero, G.—Ante-muero area, H.—Post-muero area.

I.—Radially ribbed, J.—Divaricating radially, K.—Nodulose, L.—Radially nodulose, M.—Graduated in quincunx, N.—Sulcate.

O.—Scales (mueroate, smooth, and striate), P.—Spiculose bunches, Q.—Spicules, R.—Scales and spiculose tufts, S.—Calcareous spines.

*The Girdle*.—The valves of the shell are linked together by means of a flexible integument, composed of muscular tissues, in which the insertion plates or edges of the valves are embedded. This is called the *girdle*, and its surface is variously clothed with *scales* (which may be smooth and rounded, polished, striated, flat, regular, or irregular), *corneous* or *hairy processes*, *spicules*, or a combination of two of such coverings. In some forms the girdle encroaches upon, and even wholly covers the valves. In those genera which have a posterior sinus in the tail valve, the girdle has a corresponding sinus or slit. The slitting of the insertion plates, and the covering of the girdle, form the principal characters upon which the genera are founded.

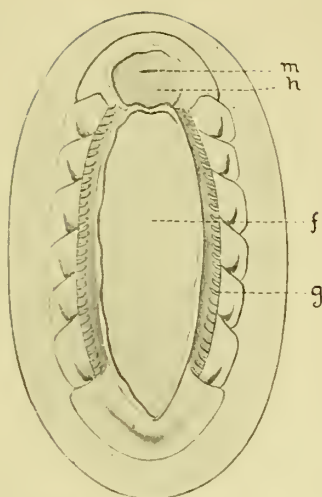


Fig. 4.—Loricated animal, as dried in shell. (When alive the foot is generally more expanded, hiding the gills). H.—Head, M.—Mouth, F.—Foot (ventral surface), G.—Gills.

*The Animal.*—The ventral surface of the Loricates consists of a fleshy foot, similar to that of the *Gastropoda*. Anterior to the foot is the head, with the mouth in the centre. The gills extend along and behind the edges of the foot from one-fourth to the entire length of the foot; commencing at the posterior end. The distinguishing feature of the Order is the symmetrical arrangement of the internal anatomy, all other *Gastropods* being asymmetrical in this respect. While there are no tentacles or eyes in the adult, many species have visible *ocelli* in the tegmentum, which are connected with the nerve-centre and are functional in conveying to the animal the sensation of light or darkness. Even where these *ocelli* are not visible, the animal is sensitive to light, and endeavours to escape from it.

The *radula*, the organ by means of which Loricates obtain their food, consists of a long siliceous ribbon bearing numerous rows of hooklets, and as this is the only hard part of the internal anatomy of most mollusks it has been largely used in grouping. In the Loricates the radula, odontophore, or lingual ribbon, as the organ is variously called, is of a complex type and can only be used by a specialist familiar with microscopic work, requiring long and careful study. As it is easily seen with the naked eye near the head when Loricates are being cleaned out, we may note the general features as follows:—Viewed with a lens it presents a spiny surface, the spines arranged in rows of about 16, two near the middle being much larger and more strongly hooked than the others. The total length of the radula may, in the larger Loricates of the Region, measure 10 mm., with a breadth of 1 mm. It is used to tear away the algal or fleshy food by a forward thrust, the small particles of food being conveyed to the stomach by retracting the ribbon.

*Reproduction.*—Dall (Scientific Results of the Exploration of Alaska, 1878) states that these animals are of two sexes, the histological characters of the male and female gland resembling those of the Limpets. Clark (*Annals and Magazine of Natural History*, 1855) observed an individual of *Chiton marginatus*, placed in a vessel of sea water, which “poured out, for several minutes a continuous stream of flaky-white viscous matter, like a fleecy cloud, and then discharged ova—not in volleys, but one or two at every second for at least fifteen minutes, forming a batch of from 1,300 to 1,500.” Lovén (*Transactions of the Royal Academy of*

Sciences, Stockholm, 1855) says that "some individuals kept in confinement laid their eggs, loosely united in clusters of from 7 to 16, upon small stones." One of us took specimens of *Heterozona subviridis* at King Island, Bass Strait, in December, 1922, and of *Sypharochiton mayi* and *Ischnochiton atkinsoni* in January, 1929, at Port Esperance, Tasmania, with clusters of eggs disposed between the margin of the foot and the gill rows. Dall (*loc. cit.*) summarises Lovén's observations in the following terms:—"The Chitons differ from most Mollusks in that the shell does not appear on the embryo until some time after they are hatched. The embryo of *Chiton cincreus* is oval, with no trace of shelly valves or depressions for them, and is divided into two nearly equal parts by a transverse depression, the margins of which are ciliated. On the middle of the upper part is a tuft of filaments which move slightly. At each end of the depression are two dark points, representing the eyes. The young when hatched become more elongated, the front part is finely ciliated, and the tuft occasionally vibrates. The hinder part extends more rapidly and becomes conic. The back is marked by seven furrows; between these the first rudiments of shelly valves make their appearance in the form of fine granulations. Soon after this, the animal can crawl as well as swim, and the mantle becomes separated from the foot by an indentation. The eyes are placed on the ventral side, and hardly visible from above. The upper anterior part of the animal is marked with acute tubercles. The mouth is not yet visible. The valves first appear in the form of seven narrow hands with irregular margins; the tuft disappears. The head and mouth then develop. The eyes are on distinct lateral protuberances. No gills have appeared. The mantle and front valve advance over the head and eyes; the tuberculated area in front of the valves is gradually diminished, and the tail-plate appears behind the seventh. The valves are at first irregular, but increase from below, and deep notches, persistent in the adult, are formed on the front edges, one on each side. It will be seen that the valves are formed each in one piece, and not by the coalescence of parts corresponding to the various areas of the adult valve."

*Food.*—So far as is known at present, the majority of Loricates are vegetable feeders, but there have been records of carnivorous habits in respect of certain individual species. We have seen *Sypharochiton maugaeus* holding a small crab under its head valve, crushed and ready for consumption. Further investigation and observation in aquaria is necessary to determine whether the known carnivores are habitually or only occasionally addicted to an animal diet.

*Ecology.*—This term is here applied to the position or *station* on the littoral or sea floor frequented by the various genera, and the interrelation of the animals with surrounding conditions. Generally speaking, the Loricates are of littoral habit, the range extending from mean high water mark to a few feet below low water mark. A small percentage of recorded species is found at greater depths below low water, those from the greatest depths being more or less degenerate forms. The station of the various genera differs, some being restricted to the upper side of the rocks; a much larger proportion being found on the under side of stones below median tide mark; while others are found amongst the roots of kelp. Those genera which are emerging and gradually becoming established in stations where they are exposed to the sun and air for the greater part of each day are generally covered with parasitic growths, or the tegmentum is so eroded as to obliterate the sculpture. These forms appear to be sedentary. The occupants of the next lower zone are more nomadic, moving freely and changing their station in accordance with the seasons and the varying surface temperatures of the water.

*Coloration of Shell.*—The coloration of the tegmentum may be divided into three categories, viz:—(1) Specific, (2) Individual, and (3) Environmental.

1. *Specific*.—Many species have a fixed colour pattern, which may extend over the whole tegmentum, or be restricted to certain definite parts, the remainder of the shell being variable in coloration, which is therefore individual. The specific colouration is always present and, within its extent, unvarying.

2. *Individual*.—Some species show no specific coloration but present a fascinating variety of colours, which may be either uniform for the whole shell, or picked out in contrasting colours and shades, the whole forming a beautifully symmetrical pattern, the markings extending over each valve in exactly the same manner on each side of the dorsal area.

3. *Environmental*.—Colour which has been absorbed or assumed as the result of some strong local influence, such as the presence of rusty iron in the pool, which imparts a reddish or brownish tinge to the shell; or the character of the rock which, if basalt or ironstone influences the shell to assume dark colours, and if sandstone or limestone causes lighter and brighter shell coloration. Evidence of protective coloration may be found in some species, but it is evanescent, dying out as the shell dries. The more brilliant shells of individual coloration are sometimes found in environments that suggest protective mimicry, but the fact that the animals are nomadic, and are just as frequently found in positions where their colour contrasts violently with their surroundings effectually disposes of the assumption that the colours are adopted for the purpose of protection.

*Teratology*.—Abnormal Loricates, having less or more than eight valves, are occasionally met with. We have collected specimens of several different species with five, six, seven, or nine valves. Though some of these abnormalities are due to fracture and subsequent fusion in repair, quite a number are clearly of congenital origin. A specimen having only three valves is preserved in the British Museum, the six median valves having become fused into one. So far, the only aberrants recorded from the Neozelanic Region are 5, 6, or 7-valved examples, but more intensive search will doubtless reveal others.

*Region*.—The Neozelanic Region, for the purposes of this Monograph, embraces the area lying between the 29th and 55th parallels of South latitude, and between the 158th meridian of East and the 175th meridian of West longitude. It includes Lord Howe, Norfolk, the Kermadec, Chatham, Bounty, Antipodes, Auckland, Stewart, and Macquarie Islands, as well as the North and South Islands of New Zealand. As it embraces subtropical, temperate, and cold waters there is a possibility of a different faunula at each extremity, some 2,000 miles apart, but curiously enough such is not well defined nor easily noticeable. While *Platiphora*, accompanied by *Hemiarthrum* are the most noticeable forms at the extreme South. *Maorichiton* and *Eudorochiton*, both peculiar Neozelanic forms, exist at the Northern extremity.

Finlay has published (Gedenhoek Verbeek, p. 168, 1925: Trans. New Zeal. Inst., Vol. 57, p. 328, 1926) a scheme proposed by Iredale for the subdivision of the Maorian Sub-Region into five provinces, thus:—

Kermadec Province . . . . . Kermadec Islands.  
 Cookian Province . . . . . North Island of New Zealand.  
 Forsterian Province . . . . . South Island of New Zealand and Stewart Island.  
 Moriorian Province . . . . . Chatham Islands.  
 Rossian Province . . . . . Subantarctic Islands, including Macquarie Island.

To which we here add the  
 Phillipian Province . . . . . Lord Howe and Norfolk Islands.

Hull proposed this name many years ago. (*Emu*, xi, 1911, 60).

In order to attain a measure of completeness we have included the Lord Howe and Norfolk Island species. These were not included in the Australian Monograph, as, although they showed a little relationship, the remainder of the

fauna failed to support any claim to close alliance between these groups and Australia. They have commonly been associated with the Kermadecs, and as there is little discordance (the only notable exotic being *Cryptoplax*, a Neocaledonian relation) we are treating them here. It may be pointed out that *Placostylus* allies New Caledonia, Lord Howe Island and New Zealand, and the parrot genus *Nestor* undoubtedly associates Norfolk Island with New Zealand. While not otherwise advising the inclusion of these Islands in the Neozelanic Region, we think that the Loricates can be here most profitably dealt with. The New Caledonian Loricates will later be fully described and illustrated by Hull and Risbec.

*Collection and Preservation of Loricates.*—A considerable number of species may be collected at low tide without even wetting one's boots, but to obtain the occupants of the lower zones it is necessary to wade into water to a depth of three feet at low tide. It is advisable, therefore, to take a change of clothing and a strong pair of boots to protect the feet from oyster shells and sharp stones. Rock eels and octopods are frequently met with in the pools, and some protection from the bite of the former and the tentacles of the latter is desirable. A short crowbar or a curved iron "erook" to lift heavy stones should be carried. To remove the Loricates from the stones to which they adhere a penknife is required, while a pin may be used for the smaller specimens. Slips of wood, one to two inches in width and eight inches in length, or of glass one by four inches, with tape or string to bind the shells thereon are necessary if "cabinet" specimens are required. Immediately upon removing the shell it should be placed on the wetted slip and gently pressed down until it assumes a natural position with the girdle well expanded. A few turns of the tape should be taken round the shell and the end left loose for the next specimen. With most shells the tape can be drawn quite tightly, but some of the more fragile shells, such as *Terenochiton* and the smaller *Ischnochitons*, require a certain amount of care as the valves are liable to become crushed. Both sides of the slips can be filled if the shells are plentiful. If it is desired to retain the animal for examination of the radula, etc., it may be allowed to remain and dry on the slip, or the slip when filled placed in alcohol. Formalin should never be used as a preservative. To make cabinet specimens of vermiform Loricates, such as *Cryptoplax*, the animal should be removed, and a boat-shaped piece of wood cut to the required length, with both ends pointed. This should be fitted into the shell, the flexible girdle adjusted, and the tape wound tightly round the whole.

If specimens are plentiful and time short, they can be rapidly transferred from the stones to the slips, and placed in a can of fresh water, in which they will drown, in most cases relaxing in dying. On reaching home the collector can remove the animals and tie the shells down at leisure. The animal should be removed by running a knife round the body, cutting from the tail forward, so as not to bring the edge of the knife into opposition to the sutural laminae. Shells having spongy girdles, such as *Onithochiton*, *Eudoxochiton* and *Plaxiphora*, should be manipulated by pressing the girdle outwards between the forefinger and thumb, both at the time of tying down and once or twice during the process of drying, or a "sausage" of cotton wool may be packed round the shell over the girdle, and the whole tied down with tape. The interior of the shell should be wiped dry after removing the animal and before tying the shell down.

When it is desired to make particularly fine cabinet specimens, too much care cannot be bestowed on the arrangement of the girdle and the disposition of the shell in as natural a manner as possible. Each specimen should be washed in clean fresh water to remove the salt, which crystallises and dulls the surface coloration. It is not advisable, however, to use any artificial varnish, vaseline or oil, for, although such media may tend to restore the brilliancy of the colouring



they invariably impart an unnatural appearance to the shell, or collect dust and hairs.

For the cabinet or display in a museum the shells may be mounted most effectively on neutral tinted cards, a very small quantity of gum tragacanth being used to attach the two ends to the card. This gum leaves no shiny trace on the card, and while holding the specimen firmly in place allows of its removal without damage. In every instance the locality where the shell was taken should be noted on the card, and in this respect the collector cannot be too precise. Such localities as "New Zealand" are too vague—the exact bay or headland should be specified, and the date of taking added, together with the name of the collector.

*Classification.*—Nearly every student has proposed an improved system in this group. Thus Dall improved upon the Carpenterian M.S., and Pilsbry put the group into good working order, so that only in detail did emendation seem possible. However Thiele, by means of intensive study of the radula, was able to indicate some amendments in Pilsbry's scheme which showed progress, and we have utilised Thiele's basis for the purpose of our reconstruction. Iredale has already suggested (Proc. Mal. Soc., xi, 1914, 27) the rejection of Thiele's *Lepidopleurina* as a primary division, and we here omit all subordinal distinction, classing the Loricates in several families without intermediate higher groupings. Ashby\* has recently essayed a phylogenetic classification of the Neozelanic Loricates, which is scarcely worthy of consideration, as his basis has involved many incompatible factors. This will be more fully discussed when we have completed the systematic description of the Loricates.

We have already shown\*\* that the *Ischnochitonidae* represent the most primitive stock and that the *Lepidopleuridae* are probably degenerates, a possibility Pilsbry was also inclined to accept when he placed the *Lepidopleuridae* as the most primitive forms. *Lepidochitonidae* and *Loricidae* are developed Ischnochitons, while the *Cryptoconchidae* and *Cryptoplacidae* may have evolved from an Ischnochitonid ancestor, with another branch developing into the *Plariphoridae*, and another into the *Chitonidae*. Thus the primitive Loricates might have had the quincuncial punctation of the juvenile Ischnochitonids or Lepidopleurids, and the scaly girdle as seen in these. No Ischnochitonid in this region has developed a hairy or spinose girdle, but *Chaetopleura* (South America) is of that form. Complex sculpture has been produced, but the insertion plates are always of simple design. The Lepidopleurids have degenerated, losing the insertion plates, while retaining primitive sculptural design. The Lepidochitonids have modified the sculpture a little, but have developed the scaling so that in some species corneous processes are seen. It should be noted that a Lepidopleurid with a hairy girdle has been found, while a series of Lepidopleurids has developed the scales into spicules. The insertion plates of the Lepidochitonids have also become modified, the teeth being coarse, irregular and brittle, but so far no loss of insertion plate is known. The *Cryptoconchidae* form a well-developed group in which the sculpture is mostly nodulose, a few developing linear sculpture as a result of the fusion of the nodules. The girdle is always spiculate, but in some cases there is almost a scale-like subordinate covering, while the insertion plates have become for the first time reducible to definite formula, the anterior valve being five-slit, the median valves one-slit, and the posterior valve with two side slits, more or less inter-slit. A further modification has produced the *Cryptoplacidae*, wherein an elongated worm-like body has been formed, the valves being diminished in size, the girdle proportionately very large, always covered with spicules, and the insertion plates long, in the anterior valve only three-slit, long in the median valves

\* Trans. N.Z. Inst., 1928.

\*\* Aust. Zool., iii., 1923, 193.

but unslit, and tending to reduction in the tail valve. Then the *Plaxiphoridae* have developed a formula of insertion plate slitting in which the anterior valve has eight slits, the median valves one-slit, and posterior valve only a callus; the girdle bearing hairy processes only.

The *Chitonidae*, as at present recognised, include a series of Loricates with the highest development, having varied sculpture, varied insertion-plate slitting, and varied girdle covering, with the two additional features of pectination of the insertion plates and visible ocelli in the tegmentum.

*Key to the Families.*

The differential features of the Families may be epitomised as follows:—

Girdle-covering scales only; insertion plates in all valves; more than eight slits in the head valve, all teeth smooth, and no scalloping present. . . . *Ischnochitonidae*.  
 Girdle-covering scales, calcareous spicules, or corneous processes; insertion plates wanting, or if present, obsolete and unslit. . . . . *Lepidopleuridae*.  
 Girdle-covering of slender scales latitudinally very closely packed, sometimes with corneous processes present; insertion plates in all valves, teeth coarsely denticulate. . . . . *Lepidochitonidae*.  
 Girdle-covering scales and spicules or corneous processes of complex growth; insertion plates in all valves save posterior valve. . . . . *Loricidae*.  
 Girdle-covering of calcareous spicules with prominent bunches; anterior valve with five slits. . . . . *Cryptoconchidae*.  
 Girdle-covering of closely-packed calcareous spicules, bunches not very prominent; anterior valve with three slits; shape very elongate. . . . . *Cryptoplacidae*.  
 Girdle-covering of corneous processes of simple growth; anterior valve with eight slits. . . . . *Plaxiphoridae*.  
 Girdle-covering of scales or calcareous spines, never of corneous processes; teeth of insertion plates finely pectinate. . . . . *Chitonidae*.

These differential features apply more particularly to Australian and Neozelanic forms. It will be seen that all the Australian families are represented in the Neozelanic Region except one, the *Callistochitonidae*. As it is quite possible that members of this Family will yet be discovered in the Region, we here give its differential features:—

Girdle-covering scales only; insertion plates in all valves; teeth peculiarly scalloped. . . . . *Callistochitonidae*.

I. Family ISCHNOCHITONIDAE.

The Family ISCHNOCHITONIDAE includes a series of generalized Loricates with simple scaly girdles and simple insertion plates; and appears to represent the most primitive form. Although the family is widely distributed and well represented, both in species and genera, particularly in the Australian region, very few species have been recognized in New Zealand, though individuals are numerous. They live between tide marks, under stones, and in the only case reported from New Zealand of two species living together, they occupy slightly different stations, differing also in their movements. The animals are the most active of the whole Order, and when a stone is turned over they quickly move to the underside, being actively responsive to light conditions or phototropic. No ecologic studies have been carried out in connection with the New Zealand species, but in Australia they have been found to move up and down as the tide varies, and also to be very liable to wander through stress of sand movement on their stations.

Though as above noted many genera have been recognised in connection with Australian species, only two are admitted in the Neozelanic series, and only one on the mainland proper. Consequently there is little difficulty in this connection

and the generic diagnosis will cover the species (save the only one not congeneric, viz., *Subterenochiton*).

i. Genus ISCHNOCHITON.

1847. *Ischnochiton* Gray, Proc. Zool. Soc. (Lond.), 1847, 126. Type by subsequent designation (*id.*, *ib.*, 168), *Chiton textilis* Gray.

Shells of medium size for the family, the largest New Zealand form less than 50 mm. in length, coloration very variable, sculpture weak and ill-defined, consisting of minute pustules, arranged quincuncially, forming on the end valves, and lateral areas through more developed design, into radials, which rarely occur on the pleural areas. Girdle scales minute, generally striate. Insertion plates sharp and clean cut, not pectinated: many slits in end valves, one slit medially on each side: sutural laminae large, widely separated.

1. ISCHNOCHITON MAORIANUS.

Plate xxxiv., figs. 1-6.

1914. *Ischnochiton maorianus* Iredale, Proc. Mal. Soc., xi. (March), 36. Otago Peninsula, New Zealand: new name for *Ischnochiton longicymba* auct.
1835. *Chiton longicymba* Quoy and Gaimard, Voy. de l'Astrol. Zool., vol. iii., 390, pl. 75, figs. 1-6. New Zealand (part). Not *Chiton longicymba* Blainville, 1825 (a *Stenochiton* q.v.).
1843. *Acanthopleura longicymba* Gray, Travels in New Zealand (Dieffenhach), ii., 245.
1871. *Chiton longicymbus* Hutton, Trans. N.Z. Inst., iv., 1870, 178.
1873. *Chiton longicymbus* Hutton, Cat. Marine Moll. N.Z., 47.
1880. *Lepidopleurus longicymbus* Hutton, Man. N.Z. Moll., 113.
1885. *Lepidopleurus longicymbus* Filhol., Miss. l'île Cauphelli, iii. (2), 531.
1892. *Ischnochiton longicymba* Pilsbry, Man. Conch., xiv., 87, pl. xxii., figs. 58-66.
1897. *Ischnochiton longicymba* Suter, Proc. Mal. Soc., ii., 186 (July).
1904. *Ischnochiton longicymba* Hutton, Index Faunae N.Z., 87.
1904. *Ischnochiton fruticosus* Wissel, Zool. Jahrb. Abth. Syst., 20, 594.
1905. *Ischnochiton longicymba* Hamilton, Col. Mus. Bull., i., 36.
1909. *Ischnochiton longicymba* Suter, Nach. Blätt. Malak. Gesell., 2, 73. (Correction of Wissel's error).
1913. *Ischnochiton longicymba* Suter, Man. N.Z. Moll., 9: Atlas, pl. 2, fig. 2, pl. 3, fig. 3 a, h.
1915. *Ischnochiton maorianus* Iredale, Trans. N.Z. Inst., xvii., 1914, 420, 425.
1924. *Ischnochiton maorianus* Odhner, Vedensk. Medd. Dansk. Nat. Foren., Bd. 77, (N.Z. Moll.), 5 (includes Auckland Is.).

Iredale's introduction reads: "For this species, which is well described and figured in Pilsbry's Monograph (Man. Conch., vol. xiv., p. 87, pl. xxii., figs. 58-66, 1892), I propose the name *Ischnochiton maorianus* n.sp. This species differs from *I. crispus* (Reeve) in its larger size, more rounded back, less distinctly striated girdle-scales, and the short posterior tooth of the insertion-plates of the median valves. *Hab.*: Throughout New Zealand. Type from Otago Peninsula."

Pilsbry's description was as follows: "Shell oblong, rather highly and broadly arched, not in the least carinated. Surface to the naked eye apparently smooth on the central, radiately lirate on the lateral areas and end valves. Color extremely variable, usually pale olive, mottled with darker olive or purple-black, or having a broad light band along the back. Lateral areas distinctly raised, sculptured with 8-12 radiating riblets, often bifurcating, the intervals densely granulated; the riblets are interrupted by irregular impressed concentric growth-lines. Central areas very closely and finely granulated in quincuncial pattern; the granu-

lation is nearly even on the jugum, although the anteriorly divergent rows of granules are sometimes slightly more prominent: on the slope between central and lateral areas, and on the extreme sides of the latter the granules are arranged to form more or less distinct longitudinal rows. The end valves are very minutely granulated and radially lirate. Umbo of posterior valve rather low, obtuse; posterior slope visibly concave. Interior green or blue, sometimes varied with red or corneous. Anterior valve with 9-12, central 1, posterior valve 11 slits; teeth thin, sharp and smooth; posterior tooth of the side insertion plates short, and terminating abruptly before attaining the posterior margin of the valve; eaves solid. Girdle closely covered with solid, convex, but somewhat flattened imbricating scales, most of which are rather weakly striated, but among which non-striated scales are mingled. Length 33, breadth 16 mill."

There is very little improvement possible on this description, but it should be noted that carinated specimens are sometimes found, and it is possible that in the Subantarctic Islands a carinate subspecies is present, but sufficient material is not available to definitely determine the exact status of the southern shells.

The coloration may be amplified as follows:—

(a) Olive-green, buff, or rose-lilac, with or without vertical lines in a darker shade, (b) wholly blackish or dark-grey, (c) black or bronze-green, with white dorsal stripe, or (d) with dorsal band of width varying on each valve, narrowest on valve iv. and widest on valve vi., (e) black or deep olive-green, with rose-lilac or other light-coloured blotches on either side of the jugum, (f) buff or other light colour, with dark dorsal stripe and anterior valve.

Dimensions: 45 x 22 mm. (Largest example measured).

Station: Under stones between median and lowest spring tide marks.

Habitat: Throughout New Zealand.

Remarks: For many years this common shell was known by the name of *Ischnochiton longicymba*, but Blainville had described his *Chiton longicymba* from King Island, Bass Strait, Australia. It was commonly accepted that the Australian (*I. elongatus crispus*) and New Zealand shells were identical, but when Pilsbry separated the two he allotted Blainville's name to the New Zealand species, whereas it obviously should have been restricted to the Australian species. Upon investigation Iredale found that Blainville had not described this species or kind of shell at all, so had no hesitation in describing the New Zealand shell as a new species, giving it the good name of *maorianus*. Later Iredale was able to show that Blainville had described a species of the genus *Stenochiton*, a very different style of Loricata, as his *Chiton longicymba* and thus definitely disposed of the confused name.

## 2. ISCHNOCHITON CIRCUMVALLATUS.

Plate xxxiv., figs. 7-9.

1847. *Chiton circumvallatus* Reeve, Conch. Icon., iv., pl. xxvii., sp. and fig. 168 (bis), Oct: New Zealand; we select Auckland Is.
1873. *Chiton circumvallatus* Hutton, Cat. Marine Moll., N.Z., 47.
1880. *Lepidopleurus circumvallatus* Hutton, Man. N.Z. Moll., 113. Campbell Island.
1880. *Lepidopleurus campbelli* Filhol, Comptes Rendus. Acad. Sci. Paris, xci., 1095. Campbell Island.
1884. *Lepidopleurus melanterus* Rochebrune, Bull. Soc. Philom. Paris, 1883-1884, 37. Campbell Island.
1885. *Lepidopleurus circumvallatus* Filhol, Miss. P'île Campbell, iii., (2), 531.
1885. *Lepidopleurus campbelli* Filhol, Miss. P'île Campbell, iii., (2), 533.
1892. *Chiton circumvallatus* Pilsbry, Man. Conch., xiv., 69. placed as a synonym of *I. (T.) cinereus*.

1893. *Lepidopleurus melanterus* Pilsbry, Man. Conch., xv., 107, description translated.
1893. *Lepidopleurus campbelli* Pilsbry, Man. Conch., xv., 107, description translated.
1897. *Ischnochiton parkeri* Suter, Proc. Mal. Soc., ii., 186, figs. 1-6, in text. Auckland Island and Campbell Island.
1904. *Ischnochiton parkeri* Hutton, Index Faunae New Zeal., 87.
1905. *Ischnochiton parkeri* Hamilton, Col. Mus. Bull. No. 1, 36.
1905. *Ischnochiton fulvus* Suter, Journ. Malae., xii., 66, pl. ix., figs. 5-10. Te Oneroa, Preservation Inlet and Brighton, Otago.
1908. *Ischnochiton fulvus* Iredale, Trans. N.Z. Inst., xi., 1907, 373.
1909. *Ischnochiton melanterus* Thiele, Revision Chitonen, pt. ii. (Chun's Zoologica, heft. 56), 111.
1909. *Ischnochiton fulvus* Thiele, Revision Chitonen, pt. ii. (Chun's Zoologica, heft. 56), 111.
1910. *Ischnochiton gryei* Iredale, Proc. Mal. Soc., ix., 91, June. (Incorrect).
1913. *Ischnochiton fulvus* Suter, Man. N.Z. Moll., 9. Atlas, pl. 3, fig. 2a-d.
1913. *Ischnochiton parkeri* Suter, Man. N.Z. Moll., 11, 1076: Atlas, pl. 3, fig. 5a-d.
1915. *Ischnochiton campbelli* Iredale, Trans. N.Z. Inst., xlvii., 1914, 419, 425.
1917. *Ischnochiton campbelli* Dupuis, Bull. Mus. Hist. Nat. Paris, No. 7, 534.
1918. *Ischnochiton campbelli* Dupuis, Bull. Mus. Hist. Nat. Paris, No. 7, 525.
1922. *Ischnochiton campbelli* Ashby, Trans. Roy. Soc. S.A., xlv., 574 (type exam. ?).
1922. *Ischnochiton melanterus* Ashby, Trans. Roy. Soc. S.A., xlv., 574 (type exam. ?).
1924. *Ischnochiton campbelli* Odhner, Vidensk. Medd. Dansk. Nat. Foren., Bd. 77 (N.Z. Moll.), 6.

Reeve described his *Chiton circumvallatus* thus: "Shell oblong-ovate, terminal valves and lateral areas of the rest sculptured with concentric ridges, central areas very minutely reticulated, posterior terminal valve umbonated; blackish-red, spotted with black, ligament arenaceous tessellated. *Hab.*: New Zealand. Approaching *C. longicymba*, but distinguished from that species by the conspicuous concentric ridges with which it is encircled."

Pilsbry included this species in the synonymy of *Ischnochiton (Trachydermon) cinereus* observing: "Carpenter, having examined the type of *C. circumvallatus* Reeve, writes that he is satisfied that it is merely a *cinereus*. The locality given by Reeve is no doubt wrong."

Apparently in this case a locality label had become misplaced, and Carpenter had not checked the specimen back with the description, as this does not apply at all to the British shell (which Iredale has collected), while the description and figure excellently depict the New Zealand species. Furthermore, Iredale examined in the British Museum a tablet agreeing with Reeve's figure, and to which Carpenter had allotted a new name. The specimens had probably been collected by some member of Ross's Voyage, which called at the Auckland Island, so we have designated that as the type locality. When Hutton wrote his 1880 Manual he included Reeve's species and gave as a locality "Campbell Island"; probably these specimens had been given by Filhol, as it is recorded that Filhol left botanical specimens in New Zealand, and Filhol used Hutton's Manual and may have shown his shells to Hutton. Then Filhol shortly described a species from Campbell Island, of which Pilsbry's translation is here copied: "Length 17, width 8 mill. Color clear yellow, last valve larger than the first, covered with concentric lines, granulated. Lateral areas marked with concentric lines, having a concavity above."

Dupuis has recently recovered a shell 12 mm. long and recorded it as type, and has been followed by Ashby, who has written: "The type is a half-grown specimen," whereas the measurements given indicate a full sized mature shell.

At the same time Filhol described a *Tonicia gryei*, and Iredale blundered badly in associating it with this species, as he was ignorant of the fact that a full complete description had been later correctly published by Filhol, making its identity certain. However, to continue, the irresponsible Rochebrune interfered with all the Loricates in the Paris Museum and, changing labels, localities, etc., introduced an almost ineradicable confusion into this group. Thus he apparently secured a lot of Filhol's specimens, and thereupon described them as a new species, as follows (again using Pilsbry's translation): "Shell ovoid, rotund; chestnut painted, with black spots. Anterior valve, posterior part of posterior valve, and lateral areas concentrically lyrate, the lyrae wide and flattened. Central areas most minutely tessellated. Marginal ligament narrow, dull rufous. Length 20, width 6 mill. Campbell Island (Filhol)."

Please note the measurements given by Rochebrune, as recently the identity of *C. longicymba* has been questioned on account of a discrepancy in Rochebrune's figures. Iredale has examined these shells and the figures given by Filhol, 17 x 8, are nearer.

The species was quite unknown to Pilsbry autoptically, so that Suter described it anew, as follows: "*Ischnochiton parkeri*. Shell oblong, highly and angularly arched. Colour very variable, from horny-yellow to chestnut-brown, mostly darker on the posterior margin of the valves, with more or less predominant black longitudinal stripes, assuming often a triangular shape, closer together or coalescing towards the girdle: the jugum with only a few or without black markings. Lateral areas distinct, raised, minutely granulated, and with three or four concentric, flat, impressed ridges, which are sometimes crossed by faint radiating riblets, their number being from 8-10. Central areas closely and finely quincuncially granulate, the anteriorly divergent rows predominating. End valves minutely decussate, with two concentric ridges, which are rendered granulose by numerous radiate riblets. Mucro of tail valve central, low, and obtuse, posterior slope slightly concave. Girdle of the same colour as the jugum, covered densely with small imbricating scales, all of about the same size; they are flatly convex and deeply grooved, 3-4 grooves on each. The margin of girdle beset with a fringe of minute spicules. Interior blue. Anterior valve with 11-13, central 1, posterior 12-13 slits: the teeth are sharp and smooth. The posterior margin of intermediate valves slightly beaked and denticulate; posterior tooth short, as in *Ischnochiton longicymba*. Eaves solid. Sinus broad, flat, smooth, channelled on each side on the inner surface of the sutural plates. Length 21, breadth 12 mm., divergence 120°. *Hab.*: Auckland Islands: Campbell Island. Specimens from Campbell Island, also in the Otago Museum, are of a light-brown colour, and were mistaken for *C. circumvallatus* Reeve. This species may be *Lepidopleurus melanterus* Rocheb., one of the many insufficiently described species."

It will be noted that Suter did not mention Filhol's *L. campbelli*, nor did he know of the long complete description given of that shell. Some years later Suter, meeting with a similar shell on the N.Z. mainland, described it as new as *Ischnochiton fulvus* thus: "Shell small, elongated oval, with the sides subparallel, obtusely angled, slopes flatly convex, fulvous. In size, outline and colour very much like *Lepidopleurus inquinatus* Reeve. Anterior valve with a few concentric ridges, minutely quincuncially punctate; the anterior margin white, the remainder uniformly fulvous. There is a slight posterior median notch. Intermediate valves. The whole surface minutely punctate like the anterior valve, with a few concentric ridges, which are more strongly developed on the lateral areas. The latter are distinctly separated from the central area by a broadly rounded edge,

and there is no indication of radiate riblets. Posterior valve concentrically ridged and quincuncially punctate like the other valves; micro subcentral, posterior slope slightly concave. Girdle covered with very small imbricating scales of somewhat unequal size. Under the microscope they are seen to be flatly convex and deeply grooved, usually four grooves on a scale. The girdle is mostly concentrically banded with white and fulvous, two rows of scales to each band. Colour varies from light to dark fulvous, the dorsal and anterior area being always lighter coloured. The anterior margin of the head valve, the anterior and lateral margins of the intermediate valves, and the entire margin of the tail valve have a narrow white border. Interior dirty white: sinus broad and deep, smooth. Anterior valve with 12 slits at unequal distances: intermediate valves with 1 slit on each side, posterior tooth small; posterior valve with 12 slits, the teeth unequal in breadth. All teeth are sharp and slightly grooved on the outer side. Length 12, breadth 7 millim.; divergence 100°. *Hab.*: Te Oneroa, Preservation Inlet and Brighton, Otago, South Island of New Zealand. The only New Zealand *Chiton* which bears a close resemblance with this species is, as already pointed out, *L. inquinatus*, which, however, may at once be distinguished by the longitudinal striated intermediate valves."

Iredale then added as regards *I. fulvus*. "It usually lives on clean smooth stones, unassociated with *I. longicymba* Q. & G. When the two occur on the same stone, *I. fulvus* Suter, is on the clean edge, whilst *I. longicymba* Q. & G. is on the muddy side underneath. *I. fulvus* Suter, is as variable as regards colour as almost any other *Chiton*, but is almost always unicoloured: it runs through all the shades from pure-white through pale-yellow to fulvous and red-brown. The most striking shell, however, is a deep-green, with a green-and-white girdle."

When Iredale worked through the collection at the British Museum in conjunction with those from the Paris Museum, he concluded that *I. fulvus* was conspecific with *I. parkeri*, which was the same as *I. melanterus* Rocheb. and *T. gryei* Filhol. Later correcting himself he determined *I. campbelli* as the correct name. Suter did not agree with the identity of *I. fulvus* and *I. campbelli*, but there does not appear to be specific separation from study of the descriptions alone, nor by the shells so far seen. The two descriptions given by Suter appear to cover every detail, the essential features being the lack of radial sculpture until senile, when deeply cut growth lines amply distinguish the species, and the few grooves on the girdle scales. We have figured an immature specimen of "*fulvus*" showing the sculpture, while the excellent figures of Reeve and Suter of the Subantarctic form will easily distinguish this.

[ISCHNOCHITON sp.]

1907. *Ischnochiton contractus* Suter, Proc. Mal. Soc., vii., 293, June. Auckland Islands.

Not *Chiton contractus* Reeve, Conch. Icon., iv., pl. xv., sp. and fig. 78, 1847 (March), which, though localized as from "New Zealand," is an Australian species.

1909. *Ischnochiton contractus* Suter, Subant. Islands, N.Z., I., 1. Same specimen.

1913. *Ischnochiton contractus* Suter, Man. N.Z. Moll., 8. Atlas, pl. 2, fig. 3.

1915. *Ischnochiton contractus* Iredale, Trans. N.Z. Inst., xlvii., 1914, 419, 425.

Suter wrote: "It is a young example, having a length of 9 mm. only, and most of the valves are broken. The colour is yellowish white, with three longitudinal rows of brown spots. The sculpture consists of the characteristic zigzag wrinkles, which are very delicate, as might be expected in such a young specimen."

This record can only be regarded as worthless until perfect shells are found].

## 3. ISCHNOCHITON GRANULIFER.

Plate xxxiv., figs. 16-17.

1909. *Ischnochiton granulifer* Thiele, Revision Chitonen., pt. ii. (Chun's Zoologica, heft. 56), 83, pl. viii., figs. 31-35. "1910": New Zealand, exact locality unknown.
1913. *Ischnochiton granulifer* Suter, Man. N.Z. Moll., 1078.

Suter has translated Thiele's description as follows: "In size and general appearance similar to *I. luteoroseus* Suter. One specimen is uniformly yellowish, the other whitish, indistinctly marbled, and with a few symmetrical reddish-brown spots near the lateral margin. The valves are rather strongly convex, angled at the middle, sides convex. The whole surface is covered with roundish granules, the lateral areas are hardly defined, the tail-valve has a central mucro with a concave posterior slope. Head valve with 13, tail valve with 8, slits. The minute scales of the girdle beset with numerous small globules fastened to a thin stalk. Marginal bodies symmetrically striated. Length 6 mm., breadth 3.5 mm. *Hab.*: The two specimens were collected in New Zealand by Dr. Thilenius, no exact locality being given."

We have copied Thiele's figures, and this constitutes all the knowledge we have of this species, which will not easily be recognised.

## 4. ISCHNOCHITON LUTEOROSEUS.

Plate xxxiv., figs. 18-23.

1907. *Ischnochiton* (*s. str.*) *luteoroseus* Suter, Proc. Mal. Soc., vii., 293, fig. 1, in text. Bounty Islands, N.Z.
1909. *Ischnochiton* (*s. str.*) *luteoroseus* Suter, Subant. Islands, N.Z. I., 2. Also from Dusky Sound, N.Z.
1913. *Ischnochiton* (*s. str.*) *luteoroseus* Suter, Man. N.Z. Moll., 10. Atlas, pl. 3, fig. 4.
1924. *Ischnochiton* (*s. str.*) *luteoroseus* Odhner, Vidensk. Medd. Dansk. Nat. Foren., Bd. 77 (N.Z. Moll.), 6. (Doubtful record).

Suter's description reads: "Shell very small, elongately oval, minutely granulate, uniformly pink or yellowish, with longitudinal pink bands. Anterior valve with a posterior rounded sinus, finely granulated in quincuncial pattern, as is the surface of all the other valves. Intermediate valves with the lateral areas hardly raised, and not well defined; slightly beaked, and the jugum sharply rounded. Posterior valve with a central mucro, a slight transverse impression below it, the posterior slope straight. Girdle scaly, scales roundish, imbricating, flatly convex, smooth, and of equal size. Colour pink, but mostly yellowish with concentric pink bands on the head valve, longitudinal, usually three on each side, on the intermediate valves, and mostly absent on the tail valve: these bands are slightly undulating or zigzagging. Interior bright pink, sinus broad and smooth, sutural laminae broadly rounded. Anterior valve with 11 slits on each side, posterior valve with 8 slits; corresponding with the slits there are radiate fine white lines in all valves. Length 5, breadth 3 mm., divergence 80°. *Hab.*: A few specimens and a number of valves in sand dredged, in 50 fathoms, near the Bounty Islands, by Captain J. Bollons. To judge from the valves gathered, the species will attain a slightly larger size, but most of my specimens are considerably smaller. The smallness, colour, and absence of radiating sculpture distinguish this species from the other New Zealand forms of the genus."

We have given original figures, prepared from paratype valves of this species: the coloration and habitat assist in determination, and it is possibly restricted to the type locality.



5. *ISCHNOCHITON INTERMEDIUS*.

Plate xxxiv., figs. 10-15.

1912. *Ischnochiton intermedius* Hedley and Hull, Proc. Linn. Soc. N.S.W., xxxvii., 274, pl. xi., figs. 3 a-b-c (December 13). Norfolk Island.

The original description reads: "Shell rather depressed. Colour variable, either a monochrome of olive, ochraceous, cream, pale or dark brown, or variegated with these tints, frequently with a dark or pale dorsal stripe. Anterior valve with numerous fine irregular, radiating riblets. Posterior valve; mucro elevated, central, with radiating riblets upon the posterior half, fewer and coarser than those of the anterior valve: anterior half similar to the central area of the median valves. Median valves: lateral areas with 4-6 faint irregular granular riblets; central areas not differentiated from the jugal tract, sculptured as in allied forms. Girdle densely clothed with minute scales. Interior, blue, sinus broad and shallow; anterior valve having 12, median 1-1, and posterior valve 12 slits. Dimensions: Length 19 mm., breadth 9 mm. Station: On the under surface of loose stones in shallow water, in sheltered pools. *Hab.*: Norfolk Island. Remarks: This shell is extremely common, and appears to occupy a position intermediate between *I. crispus* Reeve, of Australia, and *I. longicymba* Quoy, of New Zealand. Compared with *I. crispus*, the novelty is more elevated, has more definitely sculptured lateral areas, and is especially distinguishable from both *I. crispus* and *I. longicymba* by the extremely minute girdle scales." These scales are finely striated.

6. *ISCHNOCHITON KERMADECENSIS*.

Plate xxxiv., figs. 24-25.

1914. *Ischnochiton kermadecensis* Iredale, Proc. Mal. Soc., xi., 35, pl. 1, fig. 3 (March). Sunday Island, Kermadec Group.
1914. *Ischnochiton kermadecensis* var. *exquisitus* Iredale, Proc. Mal. Soc., xi., 36, pl. 1, fig. 2 (March). Sunday Island, Kermadec Group.
1915. *Ischnochiton kermadecensis* Oliver, Trans. New Zeal. Inst., xlviii., 1914, 557 (July 12, 1915).

Iredale's descriptions and comments are here reproduced, and though lengthy are worthy of consideration as still being suggestive: "Shell small, elongate, slightly elevated; valves faintly keeled; girdle scaly. Coloration varied; commonly olivaceous of various shades, sometimes splashed with lighter or darker; commonly brownish, with a brick wash fading to dirty yellow, sometimes splashed with lighter or darker markings, rarely with an uniform dorsal broad light stripe: frequently with lighter markings down the back extending on to some valves so as to recall the var. *picturatus* of *I. smaragdinus*; no specimens with the markings of the var. *decoratus* of *I. crispus* Reeve, though similar markings occur in the Neozelanic *I. longicymba* Quoy and Gaimard, not Blainville = *I. maorianus* n.sp. Other colorations and variations occur more rarely. Anterior valve faintly but closely radiately ribbed. Median valves with the lateral areas small, but similarly sculptured: pleural areas finely quincuncially punctate. Posterior valve with the posterior area sculptured as the anterior valve, the anterior area as the pleural areas of the median valves. Internal coloration generally greenish-blue, but varying somewhat according to the external coloration. Anterior valve has the smooth insertion-plate variously slit, apparently the number of slits varying with age; at least, I am unable to separate the shells specifically, though dissections give the following results: anterior 13 slits, posterior 12 slits; ant. 9, post. 8; ant. 12, post. 12; ant. 11, post. 10; ant. 12, post. 9; ant. 12, post. 11 slits. The shells with the largest number of slits are the smallest, whilst the shells with the fewest slits are the largest. This is exactly the opposite to my anticipations regarding insertion-

plate slitting. I am still engaged in the study of this variation in the slitting, and have made many dissections with no definite result as yet. Median valves have the sutural laminae short, broad, and placed far apart, the insertion-plate with one slit, the posterior tooth quite unlike either that of *I. crispus* (Reeve) or *I. maorianus* (= *I. longicymba* Auct.). In some cases it is longer than in others, but in all cases it is shorter than in the former, though longer than in the latter. Posterior valve with insertion-plate very short, and variously slit as above noted. Girdle covered with very minute regularly striated scales. Juvenile shells show a completely punctate surface, no radial ribbing being observed either on the anterior and posterior valves, or on the lateral areas of the median valves. As above noted, the slits in the anterior and posterior insertion-plates seem to be more numerous in this stage and decrease with age. Length of type 18, breadth 9 mm. *Hab.*: Sunday Island, Kermadec Group. *Station*: On the underside of clean smooth stones below low tide marks. *Remarks*: . . . the Norfolk Island shell to be more strongly sculptured, to be a longer, narrower, and higher shell, with the back rounded and no keeling present. The girdle is also broader, whilst the scales on the girdle of the Kermadec shell are even smaller than those on the Norfolk Island one. The posterior valve in *I. intermedius* has the nucro more central and more elevated, the posterior slope being therefore shorter and steeper. Upon dissection I find the posterior tooth of the insertion-plate of the median valves to be very short, at once recalling that of *I. maorianus* (= *I. longicymba* Auct.), and shorter, noticeably, than that of *I. kermadecensis*. *Ischnochiton gryei* Filhol (= *fulvus* Suter) is less elevated, has a less prominent posterior valve, and larger girdle scales."

The variety was added with the following comment: "After much consideration I have concluded to introduce this shell with varietal rank only. I collected a number of these shells and found them to be fairly constant, but here accept their identity with the common Kermadec species. This variation seems unique in Australasian *Ischnochiton*, as it does not occur in any other species to my knowledge, and I have seen nothing like it from Norfolk Island. The general coloration of the valves is cream, splashed longitudinally, but irregularly, with very pale orange, the girdle being uniformly black. The whole shell seems less elevated and less sculptured and the girdle-scales are smaller, but I have decided to disregard these points in view of the known variation of the common darker shells. The internal coloration is whitish, the insertion-plates seem shorter and more delicate, whilst the slits are twelve in the anterior valve and twelve or more in the posterior. The continual recurrence of this peculiarly coloured shell suggests that in time this 'sport' might become fixed. The peculiar coloration met with in many species of *Ischnochiton* and *Chiton* seems to support this theory. Length of type 14, breadth 8 mm. *Hab.*: Sunday Island, Kermadec Group. *Station*: With *I. kermadecensis*."

## EXPLANATION OF PLATE XXXIV.

- Fig. 1. *Ischnochiton maorianus* Iredale, whole shell.  
2. *Ischnochiton maorianus* Iredale, interior of anterior valve.  
3. *Ischnochiton maorianus* Iredale, interior of median valve.  
4. *Ischnochiton maorianus* Iredale, interior of posterior valve.  
5. *Ischnochiton maorianus* Iredale, exterior of median valve.  
6. *Ischnochiton maorianus* Iredale, girdle scales.  
7. *Ischnochiton circumvallatus* Reeve, whole shell (immature "fulvus").  
8. *Ischnochiton circumvallatus* Reeve, interior of median valve.  
9. *Ischnochiton circumvallatus* Reeve, girdle scales.  
10. *Ischnochiton intermedius* Hedley & Hull, whole shell.  
11. *Ischnochiton intermedius* Hedley & Hull, exterior of anterior valve.  
12. *Ischnochiton intermedius* Hedley & Hull, exterior of median valve.  
13. *Ischnochiton intermedius* Hedley & Hull, interior of median valve.  
14. *Ischnochiton intermedius* Hedley & Hull, exterior of posterior valve.  
15. *Ischnochiton intermedius* Hedley & Hull, girdle scales.  
16. *Ischnochiton granulifer* Thiele, posterior valve, copy of Thiele's figure.  
17. *Ischnochiton granulifer* Thiele, median valve, copy of Thiele's figure.  
18. *Ischnochiton luteoroseus* Suter, exterior of anterior valve.  
19. *Ischnochiton luteoroseus* Suter, exterior of median valve.  
20. *Ischnochiton luteoroseus* Suter, exterior of posterior valve.  
21. *Ischnochiton luteoroseus* Suter, interior of anterior valve.  
22. *Ischnochiton luteoroseus* Suter, interior of posterior valve.  
23. *Ischnochiton luteoroseus* Suter, interior of median valve.  
24. *Ischnochiton kermadecensis* Iredale, whole shell.  
25. *Ischnochiton kermadecensis* Iredale, var. *exquisitus*, whole shell.